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DEUTSCHLAND

Intern notiert:
19.4.04 / 30.4.04
Tel EPA GB

Bern, 16 April 2004/nj
our ref. RS/RS-16071
your ref.

Our File 16071
International Patent Application No. WO 03/084037
Delta Energy Systems (Switzerland) AG - Written Opinion of 18 December 2003

Dear Sirs,

1 New set of claims 1 to 17

As a reaction to the written opinion of 18 December 2003 with respect to the international patent application in caption and your confirmation of the extension of the time limit of 19 March 2004 please find enclosed a new set of claims with the claims 1 to 17 (replacement sheets 23 – 26). The international preliminary examination report shall be established on the basis of these new claims.

The following amendments have been made:

- the feature that "the power converter includes a magnetic storage element" has been incorporated into the independent claims 1 and 15;

- the independent claims 1 and 15 have been amended into the two part form by inserting the terms "characterized in that said power converter comprises" and "characterized in that said method further comprises the steps of" respectively;

The remaining claims are not amended.

2 Description

The description is amended by incorporating therein the wording of claim 3. The wording of claim 3 is inserted on page 22 of the description as the penultimate paragraph. Enclosed please find the replacement sheet 22 that shall replace the originally filed page 22. The international preliminary examination report shall be established on the basis of the amended description.

3 Short comment on the cited reference EP 1 150 417 (Murata)

Reference Murata discloses a ringing choke converter with a transformer 1 (fig. 1), a MOSFET 4 (main switch), a bias winding 8 and a control circuit 9. The bias voltage produced by the bias winding 8 is rectified, smoothed by the circuit 10 and used as an input to the control circuit 9. The control circuit 9 includes a mode switching circuit 11 and a delay circuit 12 and produces the control signal for switching MOSFET 4 (see also col. 3, line 49 - col. 4, line 9). When the rectified and smoothed bias voltage exceeds a given threshold, the mode switching circuit 11 is turned on which means that the converter now works in continuous current mode. When the rectified and smoothed bias voltage falls below the threshold, the mode switching circuit 11 is turned off which means that the converter now works in discontinuous current mode (col. 4, lines 9-15). While in continuous current mode, the bias voltage is hardly delayed by delay circuit 12, the bias voltage is delayed by a fixed amount of time in discontinuous current mode (col. 4, lines 15-22). Therefore, in a waiting state (light loads) when the bias voltage decreases, the converter is set to discontinuous current mode with a fixed delay. The delay lowers the switching frequency of MOSFET 4 and hence the efficiency in the waiting state is increased (col. 4, line 54-col. 5, line 13).

4 Patentability

4.1 Novelty

It is correct that the converter disclosed in reference Murate includes a bias winding with a subsequent control circuit that controls the switching of the main switch. However, Murata discloses that the bias voltage is rectified and smoothed. But rectifying and smoothing the bias voltage is not the same as determining its rate of change.

Therefore, neither Murata nor any of the other cited references shows a power converter as claimed. Hence, the new claims are novel.

4.2 Inventive step

The features that the rate of change of the bias voltage is determined and that the switching of a switch is controlled depending on that rate of change are essential features of the invention.

However, none of the cited documents discloses a bias winding of which the rate of change is determined and none of the cited documents discloses a power converter where the switching of a switch is controlled depending on the rate of change of a bias voltage.

In other words, it was neither known in the prior art to determine the rate of change of a bias voltage nor to control a switch depending on the rate of change of a bias voltage. It therefore can not be obvious for a person skilled in the art to incorporate these features into a power converter.

Hence, the new claims are patentable because they are novel and involve an inventive step.

5 Clarity

5.1 All claims supported by the description

It is agreed with the examiner that none of the embodiments depicted in the drawings shows a power converter that does not include a transformer. However, it is not required by the PCT (Patent Cooperation Treaty) that the subject matter of the claims has to be shown in the drawings. Art. 6 PCT just requires that each claim shall be supported by the description in its entirety.

The current wording of the claims (which do not include the limitation that the power converter includes a transformer) is very well supported by the following sentences found throughout the description:

- page 1, lines 23-24: *"A switched-mode converter includes a magnetic storage element, which may be an inductor, and frequently is a transformer for electrically isolating input from output."*,
- page 16, lines 10-11: *"Further, the bias winding may be provided in a topology that does not include a transformer, such as those shown in Figures 1-3."*,
- page 16, lines 21-23: *"As will be appreciated by one skilled in the art, the present invention may be advantageously employed in any topology which uses synchronous rectifiers."*,
- page 16, lines 23-24: *"Specifically, the present invention may be employed in topologies that include a transformer and in those that do not."* and
- page 16, lines 24-26: *"Further, the present invention may be employed in those topologies that have been previously described or referred to herein as well as in other topologies known in the art."*

Therefore, the scope of the current claims is not broader then disclosed in the description and the claims comply with the requirements of Art. 6 PCT.

However, in order to more clearly define the claimed subject matter, the independent claims are amended such that the claimed power converter does include some kind of magnetic storage element. Particularly, independent claim 1 is amended to include the feature that the power converter comprises a "magnetic storage element". Independent claim 15 is amended to include the feature "providing a magnetic storage element". These amendments are for example based on the sentence on page 1, in lines 23-24 where it is stated that *"A switched-mode converter includes a magnetic storage element, which may be an inductor, and frequently is a transformer ..."*.

5.2 Clarity of claim 3 and its depending claims

The examiner objects that claim 3 (and its dependent claims 4, 7, 8, 12 and 13) is unclear because it is not supported by the description. In order to overcome this objection, the wording of claim 3 is incorporated into the description.

This amendment of the description is based on and complies with the requirements of Art. 34 (2) b) PCT, because the originally filed claims are part of the disclosure of an international patent application. According to Art. 3 PCT, an international application shall contain a request, a description, one or more claims, one or more drawings (where required) and an abstract and while the abstract merely serves the purpose of technical information and cannot be taken into account for any other purpose, the claims can be taken into account for other purposes, for example to interpret the scope of protection sought.

Thus, claim 3 (and its dependent claims 4, 7, 8, 12 and 13) is supported by the description and therefore complies with the requirements of Art. 6 PCT.

6 Examination report

As the new set of claims and the new description overcome all of the objections of the Written Opinion a positive international preliminary examination report can be expected.

In the case the examiner requires further clarifications or does not agree with the above comments he is kindly asked for a call-back.

The representative:

Werner A. Roshardt, Patent Attorney

- replacement sheets 22 - 26
- form of acknowledgement of receipt

The key waveforms of logic diagram of Figure 12C is presented in Figure 12D. On line 500 is presented the input signal A 514, on line 502 is presented the signal after the delay cell 454. The output signal 518 of the gate 458 is connected to the reset input of 462. The output signal 520 of the gate 456 is enabling the comparator 464 during the time interval δ 416. If the output of 464 is high during 416 then Q output of 462 goes high and Vc(SR2) goes high as well. In the event wherein the output of 464 is not high during 416, then the output Q of 462 is maintained low and the Vc(SR2) skips the rising edge during this cycle.

Figure 9a shows a known switch-mode power converter in a half-bridge topology. The control signals Vc (SR1) and Vc (SR2) for the synchronous rectifiers SR1 and SR2 are determined by the control signals for the primary switches Vc (S1) and Vc (S2). The known power converter requires a current sensor shown on the line to the Load Ro. A comparator compares the sensed in current to a reference current and enables or disables the control signals based on this comparison.

Figure 9b shows a switch-mode power converter in a half-bridge topology according to the present invention. The control signals for the secondary rectifiers SR1 and SR2 are determined by the control signals for the primary switches Vc (S1) and Vc (S2), and by the rate of change of the voltage V_B in the bias winding. As previously described, under conditions when the load R_O is heavy or normal the rate of use of the voltage is such that the control signals for the synchronous rectifiers are enabled. Under conditions of light load R_O, the synchronous rectifiers are disabled.

In another preferred embodiment of the invention, the power converter further comprises a connecting portion for coupling the power input portion to the power output portion, wherein said connecting portion includes an inductor as part of said power output portion, wherein said bias winding is coupled in series with said inductor.

The terms and expressions that have been employed in the foregoing specification are used as terms of description and not of limitation, and are not intended to exclude equivalents of the features shown and described or portions of them. The scope of the invention is defined and limited only by the claims that follow.

CLAIMS:

1. A power converter for supplying an output power to a load, comprising:

a magnetic storage element;

a switching device having a switching input, a switching output, and a control input for enabling or disabling said switching device from conducting current from said switching input to said switching output; and

a network wherein said switching device input, said switching device output, and the load are connected together in a circuit;

a bias winding in said circuit for producing a bias voltage representative of the output power;

characterized in that said power converter comprises

a control circuit for

(a) determining the rate of change of said bias voltage,

(b) characterizing said rate of change, and

(c) controlling said control input as a result of the characterization (b).

2. The power converter of claim 1, further comprising a power input portion and a power output portion for providing said output power, wherein said circuit is in said power output portion.

3. The power converter of claim 2, further comprising a connecting portion

for coupling said power input portion to said power output portion, wherein said connecting portion includes an inductor as part of said power output portion, wherein said bias winding is coupled in series with said inductor.

4. The power converter of claim 3, wherein said connecting portion includes a transformer having a primary winding as part of said power input portion and a secondary winding which includes said inductor.

5. The power converter of claim 1, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

6. The power converter of claim 2, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

7. The power converter of claim 3, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

8. The power converter of claim 4, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

9. The power converter of claim 5, wherein said control circuit is adapted so that the determination (a) includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and so that the characterization (b) includes comparing the change in said bias voltage in (a) to a reference.

10. The power converter of claim 5, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

11. The power converter of claim 6, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

12. The power converter of claim 7, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

13. The power converter of claim 8, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

14. The power converter of claim 9, wherein said characterization (b) includes determining whether the rate of change is either high or low compared to said reference.

15. In a power converter, a method for supplying an output power to a load, comprising the steps of:

providing a magnetic storage element;

providing a power input portion;

providing a power output portion comprising a switching device having a switching input, a switching output, and a control input for enabling or disabling said switching device from conducting current from said switching input to said switching output, and a network wherein said switching device input, said switching device output, and the load are connected together in a circuit;

providing a bias voltage representative of the output power;

characterized in that said method further comprises the steps of

determining the rate of change of said bias voltage;

characterizing said rate of change; and

controlling said control input as a result of said step of characterizing.

16. The method of claim 15, wherein said step of determining includes comparing said bias voltage at a selected time relative to a selected starting value of said bias voltage, and wherein said step of characterizing includes comparing the change in said bias voltage in said step of determining to a reference.

17. The method of claim 16, wherein said step of characterizing includes determining whether the rate of change is either high or low compared to said reference.